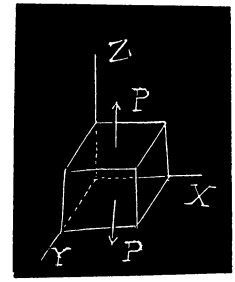
II Solution by LON. C. WALKER, A. M.

Let the figure represent a cube whose edge is unity. If a longitudinal stress $P$ be applied along the $z$-axis let the increase in length be $p$ and the accompanying decrease along both the $x$-axis and the $y$-axis be $q$. The dimensions of the solid would now be $1+p$, $1-q$, and $1-q$.




Now apply three longitudinal stresses of compression, one along each of the $x$, $y$, $z$ axes. The dimensions of the solid will now become

$$1-p+2q,\ 1-p+2q, \text{ and } 1-p+2q\ldots\ (A).$$

These three equal longitudinal stresses constitute a simple hydrostatic stress. Apply a stress of compression along one axis, and a stress of tension along an axis at right angles. Then the dimensions of the solid become $1+p+q$, $1-p-q$, and $1+p-q$.

Such a stress is called shearing stress, and the strain is $=\frac{2(p+q)}{1}$.

From the definition of Moduli we have—

(1). Bulk Modulus $=k=\frac{P/1}{3(p-2q)/1}=\frac{P}{3(p-2q)}$.

(2). Rigidity Modulus $=n=\frac{P/1}{2(p+q)/1}=\frac{P}{2(p+q)}$.

(3). Young's Modulus $=M=\frac{P/1}{p/1}=\frac{P}{p}$.

Now if $p$ and $q$ be eliminated from these three equations, there results $M=\frac{9kn}{n+3k}$.

From $(A)$, if the dimensions of the cube decrease to $1-p+2q$, the ratio of decrease is $1:1+p-2q$.

[See the subject "Young's Modulus" in Dr. P. G. Tait's *Properties of Matter*, and the sections of reference in the same book.

## PROBLEMS FOR SOLUTION.

### ARITHMETIC.

150. Proposed by F. P. MATZ, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Defiance College, Defiance, Ohio.

A commission merchant sold $\$W$,=\$4750 worth of wheat. After deducting his commission at $m\%$,=3%, purchased with the proceeds a draft at $d$,=60 days at $r\%$,=10%, interest, and at $p\%$,=¾% premium. What was the face of the draft?

151. Proposed by F. P. MATZ, Sc. D., Ph. D., Professor of Mathematics and Astronomy in Defiance College, Defiance, O.

A merchant marked a lot of goods $m\%=20\%$, above cost; but, in consequence of a rise in the market price, he marked up the goods $n\%=10\%$, on the marked price. What per cent. was the last selling price of the goods? What would be his gain on sales amounting to $\$S=\$5780.50$?

## ALGEBRA.

147. Proposed by W. J. GREENSTREET, M. A., Editor of The Mathematical Gazette, Stroud, Gloucestershire, England.

Prove that $x=a^x$ has never more than two real roots, and find the condition for no real roots.

148. Proposed by R. D. BOHANNAN, Ph. D., Professor of Mathematics, Ohio State University, Columbus, O.

If $\frac{x}{a+\alpha}+\frac{y}{b+\beta}+\frac{z}{c+\gamma}=1$, $\frac{x}{a+\beta}+\frac{y}{b+\beta}+\frac{z}{c+\beta}=1$, $\frac{x}{a+\gamma}+\frac{y}{b+\gamma}+\frac{z}{c+\gamma}=1$, show, without solving, that $x+y+z=a+\alpha+b+\beta+c+\gamma$.

149. Proposed by JOSEPH V. COLLINS, Ph. D., Stevens Point, Wis.

1. How many different football elevens can be sent out from a school having twenty players? In how many ways can eleven men line up?

2. How many sets of officers (president, vice president, treasurer, and secretary) can a society of forty persons elect? How many committees of four persons, supposing no attention is paid to positions on the committees? How many committees in which the chairman is selected?

## GEOMETRY.

177. Proposed by GEORGE LILLEY, Ph. D., LL. D., University of Oregon, Eugene, Ore.

If two medians of a triangle intersect each other at right angles, the third median will be the hypotenuse of a right triangle, of which the other two will be the sides.

178. Proposed by JOHN M. ARNOLD, Crompton, R. I.

A cylinder thirty feet long and two feet in diameter is to be placed in a machinery car, the inside dimensions of which are eight feet wide and eight feet high. Find length of the shortest car that will contain it.

179. Proposed by ALFRED HUME, C. E., D. Sc., Professor of Mathematics, University of Mississippi, University, Miss.

Of all isosceles triangles inscribed in a circle, the equilateral is the maximum and has the maximum perimeter. Prove geometrically.